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Lost species, neglected taxonomy, and the role of natural history collections and synonymization in the identification of the World's forgotten biodiversity

Spartaco Gippoliti[1], Simone Farina[2], Franco Andreone[3]

1 *IUCN/SSC Primate Specialist Group, I-00198 Roma, Italy*
2 *Museo di Storia Naturale dell'Università di Pisa, I-56011 Calci, Italy*
3 *Museo Regionale di Scienze Naturali, I-10123 Torino, Italy*
Corresponding author: Franco Andreone (franco.andreone@regione.piemonte.it; franco.andreone@gmail.com)

Abstract

A recent paper highlighted the need for increased attention towards species that have vanished from scientific literature and proposed a new nomenclature in view of needed conservation actions, based on the time interval since their disappearance. Here, we propose to implement this concept by showcasing a taxonomic perspective that is often overlooked in conservation studies. In recent decades, research on vertebrates showed that, in several cases, species considered as undescribed were, in fact, first discovered and already named a long time ago. Quite often they fell into oblivion while being considered synonyms of other taxa until they were re-evaluated in subsequent taxonomic revisions. In this context, we are proposing the concept of "long-lost synonymized" species, asking for greater attention to the discipline of taxonomy, the relevance of specimen-based taxonomy and the value of natural history collections within conservation and academic communities.

Key words: Conservation, long-lost synonymized species, natural history museums, taxonomy, vertebrates

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In a recent paper, Long and Rodriguez (2023) highlighted the cases of species that have dropped off science's radar and proposed a new nomenclature to guide conservation actions. They stated that species absent for at least 50 years should be termed "long-lost" species, those missing for more than 10 years as "lost species", and those not found for 5–10 years as "missing species". However, the authors omitted to address taxonomy in their contribution, a fundamental scientific discipline that itself can also be considered missing, threatened or lost. It is a well-known fact that the ranks of taxonomists are shrinking all around the world, and natural history museums (NHMs), where many of them usually work, are suffering a parallel decline in support (Pearson et al. 2011; Engel et al. 2021; Löbl et al. 2023).

In our opinion, unambiguously identified taxa are crucial to many biological disciplines, especially conservation biology, as they represent the first compulsory steps to enable the confirmation or rejection of any scientific study that

refers to them (Gippoliti and Amori 2002; Dubois 2003). More properly, Long and Rodriguez (2023) focused on distinct and poorly known vertebrate taxa. Obviously, no one can highlight and conserve species that are not yet known to science and/or that are not formally described, and for this taxonomy, once more, plays a crucial role. As a well-known fact, species must be formally described prior to being subjected to red list assessments, as undescribed and/or candidate species simply do not exist in terms of conservation priorities. This is why taxonomic actions are often, albeit informally, encouraged (i.e., Zachos et al. 2014).

We here report some cases regarding vertebrates, as they are better known and easier to deal with in terms of nomenclature and taxonomy. As a remarkable example we may cite amphibians, recently confirmed as the most threatened terrestrial vertebrates, with more than 41% of described species reported on IUCN Red Lists (8761 according to AmphibiaWeb 2024), but, at the same time, with many new species discovered and constantly being described (Luedtke et al. 2023). In fact, we believe that there is another category of "long-lost" species that are often overlooked by conservation literature: the synonymized (and often forgotten) taxa. Indeed, the 20th century was dominated by an overly synthetic and "lumping" approach to the study of biological diversity that resulted in a significant decrease in the number of recognized species, especially in vertebrates. Several nominal species were forgotten because they were synonymized or because they were moved to the sometimes-neglected sub-specific rank (Burgin et al. 2018). Such an approach concerns mainly the relatively well-known vertebrates, for which red lists are already available. For invertebrates the situation is quite different, with species often known from just a single specimen, the so-called "singletons" (Wells et al. 2019), and with red lists, with just a few exceptions (Neubert et al. 2019), missing.

As a consequence, the "taxonomic inertia", a term used to describe the persistence of incomplete knowledge of biodiversity due to a lack of taxonomic interest during most of the 20th Century (Gippoliti et al. 2017), propagated the remarkable prevalence and persistence of taxonomic errors. So far, the subspecies category has lost much of its scientific credibility and therefore many subspecies were *de facto* forgotten by conservation biology (Gippoliti et al. 2018). Subspecies are often not even considered worthy of conservation attention except in a few cases, mostly involving charismatic animals such as the mountain gorilla *Gorilla beringei beringei* Matschie 1903 (Gippoliti and Amori 2007). Among mammals, other than the well-known example of primates (Rylands and Mittermeier 2014), even among supposedly well-known groups, such as felids, there are overlooked species and resurrection of old synonyms, such as in the case of the Neotropical genus *Leopardus* (Carnivora, Felidae) with the recent re-validation of *L. guttulus* Hensel 1872 (do Nascimento and Feijo 2017). African canids are also little known from a taxonomic perspective. For example, the newly identified lineage of the African wolf *Canis anthus* F. Cuvier 1820 (Rueness et al. 2011) probably includes several distinct species (Allen 1939) that were later considered subspecies of a phylogenetically distinct species, the golden jackal *C. aureus* Linnaeus 1758 (Ellerman and Morrison-Scott 1951) and that consequently disappeared from science's radar for more than half a century. This seems to be the case for the recently observed wolf in Danakil that has been preliminarily assigned to *C. mengesi* Noack 1897 (Gippoliti and

Lupi 2020), a long-lost synonymized taxon. New World deer of the tribe Odocoileini offer a clear example of the effect of taxonomic inertia. At the end of the 20th century most authors recognized a total of 12 species in six genera (Corbet and Hill 1986). Nowadays, after a revival of interest in their taxonomy and the contribution of molecular techniques, the number of accepted genera is 10 with around 20 species (Gutiérrez et al. 2017; Morales-Donoso et al. 2023; Barrio et al. 2024). Interestingly, the 40% increase in recognized species in about forty years is almost completely due re-evaluation of synonyms (the only exception being the newly discovered *Pudella carlae* Barrio et al. 2024). *Bisbalus citus* Osgood 1912 (Artiodactyla; Cervidae) is another good example of a "long-lost synonymized" species. In fact, the genus *Bisbalus* is based on *Mazama americana cita*, a taxon that has been overlooked, as most other subspecies, for almost a century (Sandoval et al. 2024).

The importance of a revisionary and taxonomic working activity is even more evident in other speciose vertebrate groups, like amphibians and reptiles. In these cases, the intensification of field surveys and the use of integrative tools (i.e., biomolecular, acoustics, etc.) often leads to the reevaluation of the fauna of understudied geographic areas. Of course, the list of these works would become almost endless and is one reason for the continued description of new herpetological species (i.e., Köhler et al. 2005). As an example, in a recent work that described 24 new species in the genus *Mantidactylus* (Anura; Mantellidae) from Madagascar, a detailed comparison of historical museum types allowed the re-validation of four old taxonomic names that were formerly synonymized (and forgotten) for more than one century (Scherz et al. 2022). The availability of new techniques to extract genetic and genomic data from historical museum vouchers also led to the development of the exciting field of "museomics" that offers a further hope for filling a gap between natural history museums and biodiversity researchers (Fong et al. 2023). Furthermore, incorporating available names by generating molecular data for types of synonymized species is definitely feasible meanwhile and should be a standard protocol when describing new species using proper taxonomy. This would help in bringing these names back into scientific process and helping to avoid nomenclatorial chaos.

It is also well-known that the historical vouchers may be the only evidence for distinct and probably already extinct species, as is the case with the reptile *Lygodactylus neglectus* Ceríaco and Passos 2023 found in the herpetological collections of the Museu Nacional, Rio de Janeiro (Brazil) (Ceríaco and Passos 2023). First evidence for new species may originate directly from museum-based revisions, as in the case of the Somalian mole-rat *Fukomys ilariae* Gippoliti and Amori 2011 in the collection of the Museo Civico di Zoologia in Rome (Gippoliti and Amori 2011) or, more recently, the two new species of Neotropical small-eared *Cryptotis* shrews discovered at the Smithsonian National Museum of Natural History (Woodman 2023). In other cases, museum specimens offer definitive evidence regarding the former distributions of species and open new taxonomic questions, as is the case of the recently verified Mediterranean occurrence in historical times of the small-eye hammerhead *Sphyrna tudes* (Valenciennes 1822) (Carcharhiniformes; Sphyrnidae) confirmed by the (re)description of the specimen preserved in the NHM of Pisa University (Collareta and Farina 2023). This species is today reported only from the Atlantic coast of South America, from Venezuela to Uruguay (Pollom et al. 2020).

Hammerhead sharks have declined in the Mediterranean Sea by more than 99.99% since the late 19th century (Ferretti et al. 2008) and the reappraisal of historical sphyrnid specimens from natural history collections could help to clarify the taxonomic identity and the true extent of species diversity, and its decline, in the Mediterranean Basin.

Finally, as reported by Wheeler (2024), we underline here the central role of natural history collections in systematics, and the pivotal role of NHMs as centers for taxonomic research and preservation of voucher specimens, thus reflecting species diversity as fully as possible, even of the most obscure taxonomic groups on Earth (Suarez and Tsutsui 2004; Fisher 2019). It is therefore crucial that taxonomists and museum communities persist, and are fully integrated, into worldwide efforts to map the biodiversity of the planet, including the specific mission to rediscover and conserve lost and long-forgotten species. Only with this in mind is it possible to re-align historical collections with the new role of biodiversity assessment. And, obviously, taxonomy plays an important role in resurrecting lost species, most of which are lost in museums. It is time that international bodies, such as IUCN, recognize that biodiversity conservation needs to be fully embedded in a wider vision that is fully aware of the crucial role of botanical and zoological collections and of the people that care for them and study them. Success relies on a future with a stronger collaboration between the conservation and taxonomy communities. This will certainly help in developing conservation actions that are urgently needed.

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Author ORCIDs

Spartaco Gippoliti https://orcid.org/0000-0001-5025-7216
Simone Farina https://orcid.org/0000-0002-6109-6961
Franco Andreone https://orcid.org/0000-0001-9809-5818

Data availability

All of the data that support the findings of this study are available in the main text.

References

Allen GA (1939) A checklist of African mammals. Bulletin Museum Comparative Zoology 83: 3–763.

AmphibiaWeb (2024) AmphibiaWeb. University of California, Berkeley. https://amphibiaweb.org [Accessed 2 Sep 2024]

Barrio J, Gutiérrez EE, D'Elía G (2024). The first living cervid species described in the 21st century and revalidation of *Pudella* (Artiodactyla). Journal of Mammalogy 105(3): 577–588. https://doi.org/10.1093/jmammal/gyae012

Burgin CJ, Colella JP, Kahn PL, Upham NS (2018). How many species of mammals are there? Journal of Mammalogy 99(1): 1–14. https://doi.org/10.1093/jmammal/gyx147

Ceríaco LMP, Passos P (2023) Historical natural history collections allow the description of a new and presumably extinct species of dwarf gecko (Squamata: Gekkonidae: *Lygodactylus* Gray, 1864) from Fernando de Noronha Island, Brazil. Anais da Academia Brasileira de Ciências 93(3): e20230222 https://doi.org/10.1590/0001-3765202320230222

Collareta A, Farina S (2023) Did the smalleye hammerhead ever inhabit the Mediterranean Sea? A reappraisal of the only Italian record of *Sphyrna tudes* (Valenciennes, 1822). Acta Adriatica 64: 45–51. https://doi.org/10.32582/aa.64.1.10

Corbet GB, Hill JE (1986) A world list of mammalian species. Second Edition, British Museum (Natural History), London, 254 pp.

do Nascimento FO, Feijo A (2017) Taxonomic revision of the tigrina *Leopardus tigrinus* (Schreber, 1775) species group (Carnivora, Felidae). Papéis Avulsos de Zoologia São Paulo 57: 231–267. https://doi.org/10.11606/0031-1049.2017.57.19

Dubois A (2003) The relationship between taxonomy and conservation biology in the century of extinctions. Compte Rendues Biologies 326: 9–21. https://doi.org/10.1016/S1631-0691(03)00022-2

Ellerman JR, Morrison-Scott RCS 1951. Checklist of Palearctic and Indian Mammals. British Museum of Natural History, London, 810 pp.

Engel MS, Ceríaco LMP, Daniel GM, Pablo M Dellapé PM, Löbl I, Marinov M, Reis RE, Young MT, Dubois A, Agarwal I, Lehmann PA, Alvarado M, Alvarez N, Andreone F, Araujo-Vieira K, Ascher JS, Baêta D, Baldo D, Bandeira SA, Barden P, Barrasso DA, Bendifallah L, Bockmann FA, Böhme W, Borkent A, Brandão CRF, Busack SD, Bybee SM, Channing A, Chatzimanolis S, Christenhusz MJM, Crisci JV, D'elía G, Da Costa LM, Davis SR, De Lucena CAS, Deuve T, Elizalde SF, Faivovich J, Farooq H, Ferguson AW, Gippoliti S, Gonçalves FMP, Victor H Gonzalez VH, Greenbaum E, Hinojosa-Díaz IA, Ineich I, Jiang J, Kahono S, Kury AB, Lucinda PHF, Lynch JD, Malécot V, Marques MP, Marris JWM, Mckellar RC, Mendes LF, Nihei SS, Nishikawa K, Ohler A, D' Orrico VG, Ota H, Paiva J, Parrinha D, Pauwels OSG, Pereyra MO, Pestana LB, Pinheiro PDP, Prendini L, Prokop J, Rasmussen C, Rödel MO, Trefaut Rodrigues M, Rodríguez SM, Salatnaya H, Sampaio I, Sánchez-García A, Shebl MA, Santos BS, Solórzano-Kraemer MM, Ana CA, Sousa ACA, Stoev P, Teta P, Trape JF, Van-Dúnem Dos Santos C, Vasudevan K, Vink CJ, Vogel G, Wagner P, Wappler T, Ware JL, Wedmann S, Chifundera KZ (2021) The taxonomic impediment: a shortage of taxonomists, not the lack of technical approaches. Zoological Journal of the Linnean Society 193(2): 381–387.https://doi.org/10.1093/zoolinnean/zlab072

Ferretti F, Myers RA, Serena F, Lotze HK (2008) Loss of large predatory sharks from the Mediterranean Sea. Conservation Biology 22(4): 952–964. https://doi.org/10.1111/j.1523-1739.2008.00938.x

Fisher M (2019) The small, the hidden, the less-loved: conserving other species. Oryx 53: 199–200. https://doi.org/10.1017/S0030605319000243

Fong JJ, Blom MPK, Aowphol A, McGuire JA, Sutcharit C, Soltis PS (2023) Editorial: Recent advances in museomics: revolutionizing biodiversity research. Frontiers in Ecology and Evolution 11: 1188172. https://doi.org/10.3389/fevo.2023.1188172

Gippoliti S, Amori G (2002) Mammal diversity and taxonomy in Italy: implications for conservation. Journal for Nature Conservation 10: 33–44. https://doi.org/10.1078/1617-1381-00014

Gippoliti S, Amori G (2007) The problem of subspecies and biased taxonomy in conservation lists: the case of mammals. Folia Zoologica 56: 113–117.

Gippoliti S, Amori G (2011) A new species of mole-rat (Rodentia, Bathyergidae) from the Horn of Africa. Zootaxa 2918: 39–46. https://doi.org/10.11646/zootaxa.2918.1.4

Gippoliti S, Lupi L (2020) A note on the wild canids (Carnivora: Canidae) of the Horn of Africa, with the first evidence of a new – forgotten – species for Ethiopia *Canis mengesi* Noack, 1897. Bonn Zoological Bulletin 69: 111–115. https://doi.org/10.20363/BZB-2020.69.1.111

Gippoliti S, Cotterill FPD, Zinner D, Groves CP (2017) Impacts of taxonomic inertia for the conservation of African ungulate diversity: an overview. Biological Review 93: 115–130. https://doi.org/10.1111/brv.12335

Gippoliti S, Cotterill FPD, Groves CP, Zinner D (2018) Poor taxonomy and genetic rescue are possible co-agents of silent extinction and biogeographic homogenization among ungulate mammals. Biogeographia – The Journal of Integrative Biogeography 33: 41–54. https://doi.org/10.21426/B633039045

Gutiérrez EE, Helgen KM, McDonough MM, Bauer F, Hawkins MTR, Escobedo-Morales LA, Patterson BD, Maldonado JE (2017) A gene-tree test of the traditional taxonomy of American deer: the importance of voucher specimens, geographic data, and dense sampling. ZooKeys 697(2017): 87–131. https://doi.org/10.3897/zookeys.697.15124

Köhler J, Vieites DR, Bonett RM, Hita García F, Glaw F, Steinke D, Vences M (2005) New Amphibians and Global Conservation: A boost in species discoveries in a highly endangered vertebrate group. BioScience 55(8): 693–696, https://doi.org/10.1641/0006-3568(2005)055[0693:NAAGCA]2.0.CO;2

Löbl I, Klausnitzer B, Hartmann M, Krell FT (2023) The silent extinction of species and taxonomists – an appeal to science policymakers and legislators. Diversity 15: 1053. https://doi.org/10.3390/d15101053.

Long B, Rodriguez JP (2023) Lost but not forgotten: a new nomenclature to support a call to rediscover and conserve lost species. Oryx 56(4): 481–482. https://doi.org/10.1017/S0030605322000618

Luedtke JA, Chanson J, Neam K, Hobin L, O. Maciel A, Catenazzi A, Borzée A, Hamidy A, Aowpho A, Jean A, Sosa-Bartuano A, Fong GA, de Silva A, Fouquet A, Angulo A, Kidov AA, Muñoz Saravia A, Diesmos AC, Tominaga A, Shrestha B, Gratwicke B, Tjaturadi B, Martínez Rivera CC, Vásquez Almazán CR, Señaris C, Chandramouli SR, Strüssmann C, Cortez Fernández CF, Azat C, Hoskin CJ, Hilton-Taylor C, Whyte DL, Gower DJ, Olson DH, Cisneros-Heredia DF, Santana DJ, Nagombi E, Najafi-Majd E, Quah ESH, Bolaños F, Xie F, Brusquetti F, Alvarez FS, Andreone F, Glaw F, Castañeda FE, Krauss F, Parra-Olea G, Chaves G, Medina-Rangel GF, González-Durán G, Ortega-Andrade HM, Machado IF, Das I, Dias IR, Urbina-Cardona JN, Crnobrnja-Isailović J, Yang JH,

Jianping J, Wangyal JT, Rowley JJL, Measey J, Vasudevan K, Chan KO, Vasudeva Gururaja K, Ovaska K, Warr LC, Canseco-Márquez L, Toledo LF, Díaz LM, Khan MMH, Meegaskumbura M, Acevedo ME, Felgueiras Napoli M, Ponce MA, Vaira M, Lampo M, Yánez-Muñoz M, Scherz MD, Rödel MO, Matsui M, Filfor M, Kusrini MD, Ahmed MF, Rais M, Kouamé NG, García N, Gonwouo NL, Burrowes PA, Imbun PY, Wagner P, Kok PJR, Joglar RL, Auguste RJ, Brandão RA, Ibáñez R, von May R, Hedges SB, Biju SD, Ganesh SR, Wren S, Das S, Flechas SV, Ashpole SL, Robleto-Hernández SJ, Loader SL, Incháustegui SJ, Garg S, Phimmachak S, Richards SJ, Slimani T, Osborne-Naikatini T, Abreu-Jardim TPF, Condez TH, De Carvalho TR, Cutajar TP, Pierson TW, Nguyen TQ, Kaya U, Yuan Z, Longl B, Langhammer P, Stuart S.N (2023) Ongoing declines for the world's amphibians in the face of emerging threats. Nature 622: 308–314. https://doi.org/10.1038/s41586-023-06578-4

Morales-Donoso JA, Vacari GQ, Bernegossi AM, Sandoval EDP, Peres PHF, Galindo DJ, de Thoisy B, Vozdova M, Kubickova S, Barbanti Duarte JM (2023) Revalidation of *Passalites* Gloger, 1841 for the Amazon brown brocket deer *P. nemorivagus* (Cuvier, 1817) (Mammalia, Artiodactyla, Cervidae). ZooKeys 1167: 241–264. https://doi.org/10.3897/zookeys.1167.100577

Neubert E, Seddon MB, Allen DJ, Arrébola J, Backeljau T, Balashov I, Bank R, Cameron R, de Frias Martins AM, De Mattia W, Dedov I, Duda M, Falkner G, Falkner M, Fehér G, Gargominy O, Georgiev D, Giusti F, Gómez Moliner BJ, Groh K, Ibáñez M, Kappes H, Manganelli G, Martínez Ortí A, Nardi G, Neiber MT, Páll-Gergely B, Parmakelis A, Prié V, Reischütz A, Reischütz PL, Rowson B, Rüetschi J, Slapnik R, Son M, Štamol V, Teixeira D, Triantis K, Vardinoyannis K, von Proschwitz T, Walther F (2019) European Red List of terrestrial molluscs. IUCN, Cambridge, UK and Brussels, Belgium. https://portals.iucn.org/library/node/48439

Pearson DL, Hamilton AL, Erwin TL (2011) Recovery plan for the endangered taxonomy profession. BioScience 61(1): 58–63. https://doi.org/10.1525/bio.2011.61.1.11

Pollom R, Barreto R, Charvet P, Chiaramonte GE, Cuevas JM, Faria V, Herman K, Lasso-Alcalá O, Marcante F, Mejía-Falla PA, Montealegre-Quijano S, Motta F, Navia AF, Nunes J, Paesch L, Rincon G (2020) *Sphyrna tudes*. The IUCN Red List of Threatened Species 2020: e.T60202A3091946.

Rueness EK, Asmyhr MG, Sillero-Zubiri C, Macdonald DW, Bekele A, Atickem A, Stenseth NC (2011) The cryptic African wolf: *Canis aureus lupaster* is not a golden jackal and is not endemic to Egypt. PLoS ONE 6(1): e16385. https://doi.org/10.1371/journal.pone.0016385

Rylands AB, Mittermeier RA (2014) Primate taxonomy: Species and conservation. Evolutionary Anthropology 23: 8–10. https://doi.org/10.1002/evan.21387

Sandoval EDP, Jędrzejewski W, Molinari J, Vozdova M, Cernohorska H, Kubickova S, Bernegossi AM, Caparroz R, Duarte JMB (2024) Description of *Bisbalus*, a new genus for the gray brocket, *Mazama cita* Osgood, 1912 (Mammalia, Cervidae), as a step to solve the Neotropical deer puzzle. Taxonomy 4(1):10–26. https://doi.org/10.3390/taxonomy4010002

Scherz MD, Crottini A, Hutter CR, Hidenbrand A, Andreone F, Rosin, TF, Koehler G, Ndriantsoa SH, Ohler A, Preick M, Rakotoarison A, Rancilhac L, Raselimanana A.P, Riemann J, Roedel M.-O, Rosa G.M, Streicher J, Vieites DR, Koehler J, Hofreiter M, Glaw F, Vences M (2022) An inordinate fondness for inconspicuous brown frogs: integration of phylogenomics, archival DNA analysis, morphology, and bioacoustics yields 24 new taxa in the subgenus *Brygoomantis* (genus *Mantidactylus*) from Madagascar. Megataxa 7: 113–311. https://doi.org/10.11646/megataxa.7.2.1

Suarez A, Tsutsui ND (2004) The value of museum collections for research and society. BioScience 54(1): 66–74. https://doi.org/10.1641/0006-3568(2004)054[0066:TVOMCF]2.0.CO;2

Wells A, Johanson KA, Dostine P (2019) Why are so many species based on a single specimen? Zoosymposia 14(1): 32–38. https://doi.org/10.11646/zoosymposia.14.1.5

Wheeler Q (2024) Species, science and society. The role of systematic biology. Routledge, London, 266 pp. https://doi.org/10.4324/9781003389071

Woodman N (2023) Two new species of small-eared shrews of the genus *Cryptotis* Pomel, 1848, from the Colombian Andes (Mammalia: Eulipotyphla: Soricidae). Annals of Carnegie Museum 88(3): 203–234. https://doi.org/10.2992/007.088.0303

Zachos FE, Mattioli S, Ferretti F, Lorenzini R (2014) The unique Mesola red deer of Italy: taxonomic recognition (*Cervus elaphus italicus* nova ssp., Cervidae) would endorse conservation. Italian Journal of Zoology 81: 136–143. https://doi.org/10.1080/11250003.2014.895060